DOCUMENT RESUME

ED 200 758 CE 028 529

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TITLE Adult Problem Solving and Learning.
SPONS AGENCY National Inst. of Education (ED), Washington, D.C.
PUB DATE Apr 81
GRANT NIE-6-79-0180
NOTE 19p.; Paper presented at the American Educational Research Association Annual Conference (Los Angeles, CA, April 14, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Adjustment (to Environment); Adult Education; *Adult Learning; *Adult Literacy; Coping; Educational Research; Environmental Influences; Interviews; *Learning Motivation; Lifelong Learning; Nonformal Education; *Problem Solving

ABSTRACT

A study investigated the relationship of learning to problems that occur in the lives of adults. Of special interest were the dynamics of learning in natural/nonformal settings and the role of literacy in learning. Examination of research in reasoning and problem solving revealed two trends: increasing realization that much of what people do is determined by peculiarities and particularities of situations or context in which they find themselves, and what is important in understanding how people think and learn is not the process but the content or knowledge. Three problems were identified to aid in finding out how problem-solving and learning contribute to an adult's ability to cope with his environment. They were identification of some adults, selection of situations representative of these adults' normal task domains, and analysis and representation of adults' interaction with these situations. An interpretive framework for the research was indicated which involved interviews semi-structured, open-ended, and probing in nature. A second year of the project has been planned to involve data analysis, development of simulated problem solving scenarios, interviews with a new sample, and follow-up. Data analysis would be based on a "reduction"--a type of textual analysis accomplished in four stages: atomizing, categorizing, thematizing, and schematizing. (YLB)

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ED200758

ADULT PROBLEM SOLVING AND LEARNING

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American Educational Research Association Conference

Los Angeles
April 14, 1981

CE028529

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ADULT PROBLEM SOLVING AND LEARNING

John M. Peters, Michael Johnson, and Peter Lazzara

There are few dominant themes in the adult education literature, but one of them is that the bulk of adult learning is practically-motivated. It isn't difficult to find a majority view among researchers and practitioners regarding the importance attached by adults to the utility of what they learn in both formal and non-formal settings. Studies of adults engaged in learning projects are convincing in their evidence of a strong pragmatic orientation among self-directed learners (Tough, 1977; Peters and Gordon, 1974). The motivational-orientation studies (Boshier, 1976) are just as convincing regarding the dominance of practical reasons cited by adults who participate in formal education programs.

We are not suggesting that the only reason adults learn is to "apply" their newly-developed knowledge or skills to tasks demanded by the necessity of living, but we do mean to suggest that most, if not all, learning accomplished by adults results from their attempts to resolve problems. This assumption has led us to investigate further the relationship of learning to problems that occur in the lives of adults. We are especially interested in the dynamics of learning in "natural" or non-formal settings, and in the role that literacy plays in learning. All of this is couched in a problem-solving framework, consistent with our belief that learning is the result of a problem-solving process.

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[1]This research is supported by a grant from The National Institute of Education, NIE-6-79-0180. Requests for reprints or additional information should be sent to John M. Peters, 15 Henson Hall, University of Tennessee, Knoxville, Tennessee 37916.

Our study is in process, so we are unable to discuss findings. We can, however, discuss our rationale and methodology, and that follows.

BACKGROUND AND RATIONALE

The past few years have seen a rather remarkable increase in the number of investigators interested in reasoning and problem solving processes, and in the number of contexts in which these processes have been studied. Beginning with some early studies of reasoning in Chess masters (Chase and Simon, 1973; DeGroot, 1965) and studies of problem solving in relatively circumscribed artificial problems (Newell and Simon, 1972), the door has opened to research in the reasoning and decision making process in such diverse areas as medical diagnosis, solution of complex problems in physics and mathematics, psychiatric diagnosis, stock market prognostication, and legal problem solving.

In examining the research in reasoning and problem solving, two trends are clear, and may be causative factors behind the tremendous growth in interest in this area. The first of these trends is the increasing realization that much of what people do is determined by the peculiarities and particularities of the situations or contexts in which they find themselves. Some investigators (e.g., Jenkins, in press) have gone so far as to suggest that this is the reason that psychologists (and social scientists in general) have been generally limited in their ability to provide theories and findings obtained from laboratory research which generalize to the "real world." Given this increasingly popular viewpoint, several commentators have observed that the practical implication is to demand that research in human thought and action be studies in

situations that either are the real world that we wish to generalize to (i.e., naturalistic research), or are at least representative in the essential elements of the real world that we wish to understand, Thus, they should be "ecologically valid," to adopt the terminology used by a number of investigators (e.g., Neisser, 1976).

The second trend is somewhat more difficult to capture in a necessarily limited presentation, but is important in understanding both our current research and research in problem solving in general. This is the notion that what is really important in understanding the way in which people think and learn is not the processes by which the cognitive machine operates, but the content on which it operates. To put it another way, the way in which we think and perceive the world around us is based upon what we know, and this knowledge is what governs what we do. Perhaps a simple illustration (borrowed from Neisser) can help clarify what is meant by this: Suppose we wish to understand what makes a chess master choose a particular move, given a certain position on a chess board, in order to predict his future behavior or, by manipulating the board positions, control his future behavior. What do we need to know in order to accomplish these ends? We can immediately rule out such things as the neurophysiology of the central nervous system, flow-chart theories of information flow through the cognitive apparatus, the chess master's history of toilet training, whether reinforcement is necessary for learning to occur, whether long-term and short-term memory are really distinct entities--or, in short, most of what has occupied or continues to occupy the minds of many psychologists and educators. Given the current state of knowledge and, arguably, the future state of knowledge in these areas, it is unlikely that we will be able to accurately picture the chess master's

behavior. What would help us then? One obvious aid would be to know what the chess master knew about chess and about the consequences of his actions, given his knowledge of the opponent. It is instructive to note that chess-playing computers were remarkably inept until they began to operate on increased stored knowledge--in the form of "memorized" chess position--rather than relying on increased reasoning power. These changes took place after reasoning and problem solving studies began to tell us how chess masters function, based upon empirical evidence rather than myths about the nature of reasoning, and implied reasoning power, in chess masters.

Based upon similar assumptions, and on research findings indicating the paramount importance of content or knowledge in reasoning (as opposed to process), most recent research has focused on the knowledge aspect of reasoning; both with respect to what is known and how this knowledge is translated into action. What, for example, does an expert diagnostician in the area of pediatric cardiology "know" that a novice physician does not, and how does the expert utilize this knowledge in the context of a specific case? The key question, given this interest in knowledge, is a methodological one: How do we get at the knowledge that an individual possesses? When one stops to think about what a person knows by the time they achieve adulthood, the notion of ever capturing this knowledge in any definite way is difficult to imagine. (A moment's reflection indicates the incredible complexity and diversity of knowledge required to do such simple things as giving a stranger directions to a hard-to-find location, driving a car, or making decisions about how to set up a workshop or research project!). Fortunately, it is possible to formulate a methodology that, in several guises, has been and is being used by a large number of

investigators in a wide variety of settings. This methodology has a natural relationship to the two trends we have just described and can be illustrated by our research on the relationship between literacy, learning and problem-solving in adults. This research is illustrative, but not definitive, of the approaches that can be taken in this area.

In reasoning research in general, and in our research in particular, the methodology is based upon several presuppositions which can be both empirically and theoretically justified. We can specify these presuppositions very briefly as follows:

1. Human action, both overt and covert, is intentional or goal directed. What we do is always toward some end, and is purposive. This is not to say that all action is "rational" in the generally accepted meaning of that term, or that the goals or purposes which actions serve are always explicitly or consciously known, though they often are.

2. Human action is rule governed, in the sense that what we do is based upon explicit or implicit instructions that we give ourselves. These may be of the general form "given X (situational factor), do Y (action)." Again, these rules or instructions need not be formally rational or logical, or even part of our conscious awareness--unless they are purposively brought into our awareness.

3. The instructions we give ourselves, and the actions which they give rise to, are based upon what we know about the situation we find ourselves in and the world in general.

4. The content and organization of what we know adapts or changes in response to the situations in which we find ourselves, and in which we have found ourselves in the past.

5. Adults do not merely respond to situations, they also help create them; and in doing so, their actions become part of the situation itself. Relationships between the individual and his environment do not form a causal chain, but instead form a set of relationships which map onto each other.

6. People are, at any given point, products of the adaptations they have made, which are in turn functions of the situations they have encountered, and their genetic structure. The outcome of adaptation is some form of internal representation from which an individual can derive a set of rules or procedures to guide action in a given situation (Neisser, 1976; Piaget, 1954).

7. Learned behavior is the result of adaptation to a complex set of environmental structures and task demands, and this adaptation is the foundation for the body of operative knowledge of problem solving in the various domains of the adult. Although adaptations generally occur to specific situations, and the rules related to these adaptations are those which are applicable to specific situations, at some point adaptations to several related situations come together into more general meta-adaptations or inductive principles, which represent a general approach to problem solving. The nature of the adaptations largely determines the variation in problem solving approaches employed by adults.

8. To describe adult behavior strictly from the point of view of the observer is to fail to appreciate the fact that the physiologically relevant aspects of situations and actions can only be determined with reference to a behaving organism, that is, from the point of view of the actor (adult learner/problem solver). It also fails to provide a

way of probing the adult's own meanings, which may be the most important elements in a behavioral event.

9. It is possible to obtain valid information concerning the intentions, rules and knowledge which generate human actions (as well as to monitor changes in these), through the use of first person accounts made by individuals engaged in some sort of activity. These accounts (which ultimately emerge as protocols) can then be used as primary data in the study of reasoning--provided that one is aware of certain dangers which might lead to overinterpretation (Erickson and Simon, 1979).

Given that a general introspective account might be constructed through the cooperation of an individual and an appropriate outside observer, there may remain some problems with the method itself. These include:

1) It is difficult to arrive at an objective test of the adequacy of an introspective account; i.e., is it really the basis for how the adult solves problems and learns, or only a verbal realization?

2) Introspective accounts are difficult to communicate in a form that can be understood and utilized by a novice or interested outsider.

3) Introspective accounts are non-generative. They make it difficult to account for the adult's ability to learn or solve problems in situations different from the one in which the data are being collected.

Some solutions to these problems can be found in: (1) developing a comprehensive and adequate representation of learning and problem solving in a relevant task domain; (2) using verbal protocol data, in which the emphasis is upon description rather than explanation for information sought and actions taken in learning/problem solving episodes; and (3) calling for periodical and near-term reports of learning/problem solving efforts, rather than relying on extensive and one-time recall.

The fact that introspective methods usually involve verbal reports does not mean that verbal reports are not in themselves potentially useful. Their use, however, ought to be clearly related to the researcher's assumptions about human behavior, since his/her assumptions largely determine the research methodology and theoretical representations employed.

METHODOLOGY

To find out how problem solving and learning contribute to an adult's ability to cope with his environment, the solution to three problems is required: (1) Some adults need to be identified; (2) some situations representative of these adults' normal task domains must be selected; and (3) the adults' interactions with these situations must be analyzed and represented. To utilize this perspective in research, an investigator should look for regularities in problem situations, regularities in the meanings of interpretations applied to situations, and regularities in the actions produced by adults.

Such an investigation would be conducted within what Hudson (1975) calls a "hermeneutic" framework. Although this term has a more technical and restricted meaning in philosophy and textual analysis, it can be taken to mean that investigation ought to begin from an interpretive rather than a hypothesis testing perspective--in which the investigator is free to use any and all sources of information in an effort to arrive at a "best reading" for the problem on which he is working. This means that an investigator of problem solving and learning by adults can, for example, make use of adults' accounts of their own actions as a first step in describing problem solving/learning, and in providing an important source of information for determining what to look for in the adults'

own environments.

The adoption of a hermeneutic perspective does not imply that experimentation is not worthwhile, or that methodological and explanatory rigor can be abandoned. What it does suggest is that experimentation can be more usefully employed to test and refine a theory or representation which has been arrived at by other means, rather than as a primary discovery procedure for producing a theory in the first place. Experimentation should not take place in the absence of a thorough initial conceptualization of the phenomenon of interest.

One corollary of approaching research initially from an interpretative rather than predictive point of view, is that the process of arriving at a best reading (or determining what to look for) should be regarded as an iterative one. That is, one begins with a preliminary conceptualization based upon whatever data or evidence is available. This preliminary conceptualization provides an initial focus (or theory) which can be refined in a series of successive approximations as more and more evidence is examined and investigative sophistication is increased.

The final outcome of this study, however, may be only a beginning for future research efforts. For example, in the near future, we should be able to statistically relate the "mechanics" of adult problem solving/learning activities to such variables as the adults' ability to use written communications. We should be able to develop protocols that describe adults' approaches to solving problems, and to actually manipulate the protocol elements to produce different and measurable responses to simulated problems. In the final analysis, we should produce the kind of material that can actually be used to develop computer simulations or models of adult problem solving/learning episodes. In

short, we would begin to identify mechanisms for highly controlled research into the area of problem solving and learning. Our approach is consistent with Neisser's (1976) concept of "ecologically-valid" research, an important distinction when compared to the approach taken by most other problem solving researchers. Neisser's stress on the need for ecological validity is based on his observation that most current experimental methods dealing with learning and problem solving ignore important aspects of the environment. He maintains that contemporary studies of cognitive processes usually use stimulus material that is obscure, discontinuous, and only marginally real. The proposed study seeks to avoid this problem by beginning with real problem situations and developing stimulus material from these situations.

PROCEDURE

To bring the above presuppositions into the framework of our current research, and the concrete procedures we are following, is a relatively straightforward step. We are interested in how people deal with the problems they encounter in everyday life, and in how literacy is involved in the way this is accomplished. In order to do this, we must (to avoid the dangers of laboratory artificiality) try to study problems actually encountered by people. This we accomplished by interviews with a relatively large population of adults. As a first step we have simply asked them to provide accounts of their methods and activities in attempting to solve particular problems which they face in their day-to-day experience. The interviews are transcribed and analyzed to produce a "model" or representation of individual problem solvers in the context of their particular problems.

These representations can then be used for two purposes, some of which are already accomplished and some of which are contemplated in the current research. First, the representations can be analyzed to provide information concerning the process of reasoning in general, possible differences in literate and non-literate reasoning, and individual differences in the solution of problems. Second, the representations provide the basis for simulation models of individual problem solvers, which can then gengrate predictions to be tested in the context of future problem-solving research on these individuals.

The first year of the two-year project involved the collection of interview data from samples of literate (N=90) and illiterate[2] (N=90) adults. Each subject was asked to identify a problem that occurred in his/her life near the date of the first interview. The initial interview was followed by up to five additional interviews spanning a period of six months or until the person's problem was solved, whichever came first. In some cases, the series of interviews was terminated at the option of the interviewee, or due to the loss or interviewers who had sole access to interviewees.

The interviews were semi-structured, open-ended, and probing in nature. The principal objective of the interviewer was to obtain such information as: (1) the problem definition; (2) the steps taken by the interviewee to resolve the problem; and (3) the reason why the steps were taken. Additional information collected during the interview included the kinds of resources used by the problem solver, obstacles

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[2]We define an illiterate adult as a person who reads at less than a fourth-grade level.

encountered, and decision factors affecting his/her problem solving strategy.

Perhaps the most important characteristics of the interview process were: (1) it did not require the interviewee to analyze his/her own cognitive processes (as is required in some uses of verbal reporting); and (2) the questions asked were not selected on the basis of a pre-determined set of hypotheses.

Each interview was recorded on audio tape and transcribed verbatim in the form of typed transcripts. The transcripts (protocols) then served as the data base for subsequent analysis. Currently, we have on file 382 interview transcripts.

The second year of the project involves the analysis of data from Year One, the development of simulated problem solving scenarios, and interviews with a new sample of adults who will engage in hypothetical problem solving situations. Year Two will also involve follow-up interviews with selected members of the Year One sample, for the purpose of testing predictions made on the basis of Year One data.

We are currently developing techniques for storing and retrieving Year One and Year Two data with the use of remote computer terminals and printers tied to the University's main-frame computer system. We anticipate several benefits from this procedure, including: (1) the ability to "record" interview information directly on computer tape without intermediate transcription; (2) the manipulation of protocol data while avoiding the need to type transcripts on paper; and (3) the design of computer-based problem scenarios with accompanying decision factors designed to influence the problem solver's strategy as he/she interacts with the computer.

ANALYSIS OF DATA

Our analysis is based on a method of protocol analysis which we refer to as a "reduction." A reduction is a textual analysis which takes the form of a search for thematic structures and these structures are the underlying meanings that are uncovered through a systematic manipulation of the basic analytical units of the text (which we call atoms or intended interpretations). The reduction moves through several steps of analysis, beginning with the original transcript and ending with a succinct and integrated description of the subject's problem solving process and rationale. The reduction is accomplished, in part, by eliminating redundant and tangential information and reorganizing the data so that it can be easily analyzed. The reduction is accomplished in four stages: Atomizing, Categorizing, Thematizing, and Schematizing. The four stages comprise what we term an "ACTS" analysis.

In the first stage, the transcript is segmented into what we call intended ideas, or "atoms." Atoms (roughly, sentence paraphrases) are listed individually and numbered. In the second stage (categorizing) each atom is placed into one of six categories: law, norm, intention, want, belief and fact. This list of categorized atoms is the data base from which we draw the material for the third and fourth stages of the reduction. In the third stage (thematizing), we examine each category of the data base for natural and logical connections among atoms. From these underlying commonalities we derive themes, which are essentially generalizations over sets of atoms. In the fourth stage (schematizing), we formulate a preliminary representation for the problem solving process.

This representation takes the form of a flow chart with its major elements derived from the category of intentions.

When the above analysis is complete we have what we refer to as a model of the person as a problem solver. The model is composed of two primary elements: (1) a picture of the problem solving process that the person uses, which we refer to as their "style," and (2) a structured record of the person's accounting practices which consists of the person's rule system. The resulting model is, in essence, a depiction of the person's reasoning pattern applied to a specific problem situation.

When we first analyze a transcript, we derive a flow chart of the specific problem the person solved and this flow chart is generalized. We treat this generalized flow chart as an hypothesis about the person's typical problem solving style. This hypothetical problem solving style is analyzed according to content and such formal variables as: complexity, density, completeness and rationality.

a) complexity is measured by a relative count of the decision points in the generalized flow chart.

b) density is a measure of the number of procedural steps which are typically considered by the problem solver.

c) completeness is a measure of the range of application of the style to other problems.

d) rationality (at this level) is a qualitative analysis of any possible inconsistency among the potential problem solving behaviors that can be generated by our model.

The rules that guide a person's behavior with regard to a specific problem domain are examined for various kinds of logical implications. The rule structures are not usually articulated by the person and must be deduced by the analyst.

The rules a person follows in the regulation of his day-to-day conduct are called low level themes. At the beginning of the thematization stage, we are interested in these low level themes that will later be constructed into increasingly abstract thematic structures. In each movement, from the specific to the general, we always want to be able to keep a close and reasoned connection with the proper stages. That is, each reduction is carefully constructed out of the original data. Our goal is to be able to move through our model of the person both deductively and inductively. We move deductively when, from the most general principles (those we have called moral and ideal norms), we can make logical deductions which are, in essence, predictions about choices among problem solving strategies which are intellectually and physically available to the subject. We move inductively when we go in the other direction. That is, when we gather new problem solving information and accounts from the person which either confirm our model or lead to refinements and modifications of that model.

Prediction is founded upon the following axiom: from a knowledge of the whole system (the "model" as we defined it), and a knowledge of any part of the system (e.g., a particular rule subsystem), we can predict or derive any other part. Predictions can be made with regard to either natural or artificial problem situations. The person can be put in a hypothetical problem situation, for example, and generate responses which serve as data to confirm predictions made by the model. The person can also be observed in a natural environment solving problems typical of their capacity or expertise.

In addition to the products generated by the ACTS analysis, the analysis of introspective protocols produces additional information, such

as the following (which can then be related to a preliminary characterization of problem solving):

1) The situational information utilized by the problem solver, or the aspects of the task situation which are attended to.

2) Kinds of additional information sought by the problem solver.

3) Attempts by the problem solver to recast or transform the task environment as it is presented.

4) Short-cuts, algorithms, or rules of thumb used.

5) Kinds of outside resources used by the problem solver.

6) Obstacles encountered while resolving a problem.

7) Locus of control, or perceived source of problem as seen by problem solver.

8) Domains of problem activity.

9) Sense of efficacy felt by problem solvers.

10) Egocentricisms, or idiosyncrasy of the problem solver's beliefs, roles, etc.

11) Metaknowledge, or the problem solver's perception of his/her problem.

12) Evidence of flexibility vs. dogmatism during problem solving.

13) Long range vs. short range planning perspectives of problem solvers.

14) Conceptual orientation of problem solvers.

We are currently in the process of refining additional content analysis procedures and appropriate sealing procedures, in order to identify and measure much of the data generated by the above. The results of the ACTS analysis will be reported by the end of 1981.

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